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## ABSTRACT

This paper compares the beliefs and practices of six elementary education majors prior to and during their senior year clinical and student teaching experiences. Three of these preservice teachers had the minimum requirement of two mathematics content courses. The other three were mathematics specialists and had at least six additional courses in mathematics. Comparisons are made from data, pre-intervention baseline to post-student teaching, on their teaching practices and on their reported beliefs. Although results from this comparison suggest that the change profiles of these two groups are different, at the end of their student teaching experience these two groups were not significantly different in their teaching practices and in their reported beliefs. (Author)

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# Content Knowledge, Beliefs, and Practices: A Comparison Among Six Preservice Teachers

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## CONTENT KNOWLEDGE, BELIEFS, AND PRACTICES: A COMPARISON AMONG SIX PRESERVICE TEACHERS

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This paper compares the beliefs and practices of six elementary education majors prior to and during their senior year clinical and student teaching experiences. Three of these preservice teachers had the minimum requirement of two mathematics content courses. The other three were mathematics specialists and had at least six additional courses in mathematics. Comparisons are made from data, pre-intervention baseline to post-student teaching, on their teaching practices and on their reported beliefs. Although results from this comparison suggest that the change profiles of these two groups are different, at the end of their student teaching experience these two groups are not significantly different in their teaching practices and in their reported beliefs.

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Typically, elementary education majors believe mathematics is a set of rules and procedures (Ball, 1990; Ball & Wilcox, 1989). The image they have of what teaching is, influences what they do with their student teaching experience (Calderhead, 1988). Their methodology involves a "show and tell" approach and they believe listening to children is an important factor in the learning environment (Feiman-Nemser, McDiarmid, Melnick, & Parker, 1989). Often, they tend to teach as they were taught (Ball, 1990; Lappan & Even, 1989). Since teachers' understanding of mathematics is an integral component of their knowledge base for teaching (Ball, 1991), it could be assumed that an increase in mathematics understanding would have a positive effect on teaching practices. The purpose of this study was to provide insights into the effect of an increase in mathematical knowledge on teaching practices by comparing the reported beliefs and observed practices of elementary K-9 mathematics specialists and non-specialists.

### The Project

This study is part of a five-year National Science Foundation grant that is designed to prepare teachers to base their instructional decisions on research findings about children's mathematical thinking. During the initial phase of the project, 25 experienced K-6 teachers developed learning environments to reflect their perception of teaching mathematics for understanding. This was done in collabora-

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tion with university researchers and involved a four week summer seminar, classroom visits, and a bi-weekly meeting for one school year. During the second phase of the project twenty-five K-9 preservice teachers joined the project. In the summer preceding their senior year, a two week summer seminar was held in which experienced and preservice teachers collaborated on mathematical tasks. In the fall semester the preservice teachers were enrolled in the same mathematics methods class where they had access to the same information and research that the experienced teachers had had during the previous year. Further, as part of their clinical experiences the preservice teachers were assigned to observe and teach for six hours per week in the classrooms of the experienced teachers. For the student teaching experience during the spring semester, the preservice teacher was assigned to a different grade level with another experienced teacher. During the fall and spring semesters, both the experienced and preservice teachers attended bi-weekly meetings conducted by the university staff.

### **Data Collection**

Data collected on the preservice teachers included information from the Perry Scale, a written belief survey, a belief interview, and pre- and post-intervention video tapes of model mathematical lessons followed by stimulated recall interviews.

### **Subjects**

Three mathematics specialists Barbara, Quincy, and Faith and three non-specialists Evelyn, Nancy, and Wanda (pseudonyms) were selected for more in-depth analysis. Barbara and Nancy student taught in a second and first grade classroom, respectively. Evelyn is a non-traditional student having an undergraduate degree in psychology. She and Quincy were both placed in fifth grade classrooms. Wanda experiences great degrees of mathematics anxiety. She and Faith were at the same school teaching sixth and fifth grade, respectively. Both were in departmentalized situations and taught mathematics throughout the day. Selection of these six was based on commonalities in their grade-levels taught for both clinical and student teaching experiences, of their Perry scale ratings, of their belief survey results, and among their cooperating teachers.

### **Findings**

The analysis of all data focused on the observed and reported changes of the preservice teachers with respect to their beliefs, practices, and decision-making processes before, during, and after the intervention. This is approximately a period of one year.

**Written Beliefs Survey.** The written belief survey was adapted from the Cognitively Guided Instruction project (Peterson, Fennema, Carpenter & Loef, 1989). A high score indicates a reported belief that learning and teaching decisions need to be based on the consideration of developing students' understandings. Prior to any intervention, the range of belief scores for all mathematics spe-

cialists ( $n=6$ ) went from 3.08 to 4.5. Non-specialists ( $n=19$ ) ranged from 3.04 to 4.0. After intervention, the range for the mathematics specialists was 3.6 to 4.8 and for the non-specialists from 3.56 to 4.8. We conclude there was no significant difference between the two ranges at the end of the intervention.

**Stimulated recall interviews.** A videotape of a 15 minute model lesson was made prior to any intervention. Three other model lessons were also taped, one during the clinical experience and two during the student teaching experience. A stimulated recall interview was conducted after each of the last three taped lessons. Comparisons were made of the students in areas identified as relevant (Lubinski, 1990) and related to lesson planning: objectives, content, materials, task selection, consideration of students, and role of assessment.

**Objectives.** Nancy and Evelyn both shifted from focusing on review and practice of appropriate operations for their grade level to developing strategies for use in word problems which involved all four operations and allowed for multiple solution strategies. Wanda initially focused on increasing student knowledge through the use of definitions and formulas and developed her style to focus on finding solutions to problems that she felt were the types to which her students could make connections to real life situations.

Barbara and Quincy moved in different directions. Barbara's focus went from an open-ended perspective to one being linked to a review or task in which she was only minimally focused on the mathematics involved. Quincy shifted from evaluating equations to teaching more open-ended types of problems that allowed for multiple strategies. Throughout her involvement in the project, Faith had the objective of teaching mathematics by placing her problems in a real-world setting.

**Content and Task selection.** For ease of comparison, all subjects were instructed to focus on whole number operations during the videotaping of any model lesson. All subjects except Barbara developed teaching styles that incorporated problem situations reflecting students experiences and interests. Both Evelyn and Faith began with problem situations and continued with this style throughout their teaching experiences.

Nancy selected tasks that were fun, informal, and non-threatening in her initial lesson, posing word problems with sums less than 20. These problems appeared contrived rather than based on students' interests or experiences. One year later her problems included not only all four operations and whole numbers, but also fractions. She now selects activities that are integrated with literature, makes connections to previous mathematics lessons, and focuses on problem solving. Her lessons appeared to be influenced by tasks presented in the methods course and at project meetings.

The content of Evelyn's lessons were influenced by her belief that students need challenge. Evelyn consistently used small groups and developed her own activities that she believed would relate to real-life problem solving, for example, a game of Jeopardy. She went initially from focusing on one operation problems to more open-ended problems.

At first, Wanda focused on formulas and definitions and tasks that focused on computational proficiency. Later she developed a style using more relevant prob-

lems that involved interpreting and solving written word problems. Wanda also used group work but struggled to have her students complete tasks in the assigned time and was aware that her limited mathematics background contributed to her inability to implement lessons that flowed smoothly. The implementation of her lessons appeared to be influenced by her cooperating teacher's style.

Barbara initially used problems with multiple answers which incorporated all four operations. In her last three lessons she used problems which did not readily allow for multiple answers or alternative strategies. Her additional mathematics background experiences were not readily apparent in their selection of tasks. Barbara's task selection during her student teaching experience appeared strongly influenced by her cooperating teacher, who interrupted her several times during the videotapings.

During initial and clinical videotapings in grade one settings, Quincy's content went from join change unknown problems using numbers under 20 to making connections between repeated addition and multiplication. During student teaching, Quincy selected tasks to develop understandings related to curriculum guidelines and to which students could relate. However, during this time, his groups were structured in order to keep students on task and control behavior, not to develop understanding. During his final videotape, he appeared anxious and focused on controlling behavior more than usual. He relied heavily on his own perception of how mathematics should be taught and struggled to establish a working relationship with his cooperating teacher.

Faith was consistent with using topics to which the children could relate. In the model lesson during her first grade clinical experience she selected to teach comparison problems. That is, she did not focus on developing strategies, but rather on teaching problem types. By the end of her student teaching experience she was still using interesting problems, but incorporating techniques to develop students' thinking. Her content selection was often influenced by the experiences she had within the mathematics department.

**Materials.** All used a variety of materials but for different reasons. Nancy initially selected materials that were "fun for the students". As they developed their teaching style, both she and Evelyn realized that some materials and manipulatives can detract from the learning. Nancy's choice of materials became dependent upon student behaviors and she resorted to paper and pencil during her final two lessons. Evelyn often selected materials based on assumptions she made about how the students would use them to develop their thinking. Wanda used materials that suggested strategies for solving the problems posed.

Both Barbara and Quincy initially used only paper and pencil, but progressively used more materials; however, their rationales for doing so differed. Barbara's materials were related to projects needing to be completed before the mathematics could be introduced. Quincy introduced materials and manipulatives to develop diverse thinking strategies. Faith used a variety of visual aids and manipulatives throughout.

**Consideration of students and the role of assessment.** Initially, Nancy based her decision on her conceptions of what students can do at a particular grade level

and on what they like. She was aware that the level of difficulty of the problems may have been inappropriate because she asked the students at the end of the lesson if the problems were too easy. She developed an awareness of her students' understandings and interests, tried to incorporate assessment as part of instruction, and began to make connections among the strategies collected. In her final lesson she was aware of different students' abilities based on the kinds of strategies they used and considered this in planning. During instruction at the end of her student teaching experience, she solicited students' thinking but did not alter plans or pose follow-up questions based on their responses.

Evelyn assessed continually as she taught. In her initial first grade situation, the second sentence she said was, "How high can you count?" She became increasingly aware of her students' strategies and modified her lessons accordingly. She had the students verbalize their thought processes to not only develop their understandings, but to collect information about their thinking. She progressed from simply collecting strategies to comparing the strategies suggested. This indicates a more developed level of pedagogy than exhibited by most of the other student teachers.

Wanda had preset assumptions of what the students knew. Initially, she made little effort to solicit students' thinking. During her clinical experience, she focused more on her own thinking even though she solicited students' ideas about their thinking. She developed her questions to better determine how students were thinking about solving a problem by stating, "Could you walk me through it" or "How do you know?" Consideration of students' experiences was not apparent until the final lesson in which problems were taken from real-life situations but there was little evidence of assessment in lesson planning.

Barbara considers students' background throughout her teaching experiences, however assessment was often based on assumptions. There was little evidence of using students' thinking to formulate questions during instruction or to plan for further instruction. Emphasis was more often on a procedure, not on understanding the concepts. She frequently referred to "doing procedures correctly" as providing evidence of understanding. Her emphasis was on obtaining the right answer.

Quincy initially based his decisions on what he perceived interesting to the students, considering their skill level. At the end of student teaching he exhibited an increased awareness of and ability to illicit students' thinking and multiple problem solving strategies. He professed to address a variety of cognitive styles he believes his students possess. Quincy's assessment progressed from walking around the class watching students work to adjusting problems to individual's abilities based on their responses. Faith considered students' interests, experiences, and needs throughout. She focused on their strategies, maintained a flowing dialogue, and used both written and verbal feedback for assessment.

### **Discussion**

It was hoped that an increase in the amount of mathematics coursework where instructors modeled reform-based pedagogy along with a change in reported beliefs

would affect teaching practices. Our results suggest that it is not clear what effect more experiences with mathematics being taught for understanding has on teaching practices specifically during student teaching. Other factors may be of greater influence. The cooperating teacher and classroom environment were major influences on some specialists and non-specialists alike, but for others there was little evidence of this. One mathematics specialist was influenced by her mathematics project and non-project experiences, while another appeared to be influenced only minimally by the mathematics coursework. Overall confidence allowed two of the mathematics specialists and one of the non-specialists to be less concerned about control within the learning environment. We attribute this in part to their mathematics backgrounds, level of maturity, or level of cognitive development.

If teachers tend to teach as they were taught, the question becomes "Taught when?" Further, the "show and tell" approach discussed in the literature extended with our preservice teachers to collecting strategies without making connections among them. Our conclusions at this time suggest that there are many factors that affect teaching practices. Rich descriptions are still needed of the relationships among preservice teachers' beliefs, knowledge, and practices. Further, it is important to follow these new teachers as they begin to teach in order to determine if our findings are consistent over time.

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